Notes on Multiple Stressors approach in IEP 2010 Pelagic Organism Decline Work Plan and Synthesis of Results

They do not call them stressors, but rather use the term "drivers" since they are factors that drives species distribution and abundance and there is the tendency to make them look bad.

Grouping of these drivers into four general classes: previous abundance, habitat, top-down effects and bottom-up effects.

Recognize that there has been an ecological regime shift that followed a longer-term erosion of ecological resilience. A working hypothesis to be tested by future research.

Previous abundance: note that use of population indices, rather than population size, obscures the effects of stock-recruitment relationships. The size of the population one year has an impact on the size of the population the next.

Habitat: they make the important point that changes in habitat affect fishes directly and indirectly, by affecting predators and prey. They conclude that declines in suitability of habitat appear to be important in the long term declines of all POD species. Key drivers of change are declining turbidity and salinity, which promote non-natives over natives. Also see ammonium, Microcystis, toxic chemicals (acute, not chronic), declining food webs. Pyrethroids and endocrine disrupting compounds are of concern.

Top-down. Refers to mortality from predation and entrainment into water diversions. Non-natives playing an important role in reducing native populations. SWP and SVP operations cause mortality as well. Have a conceptual model for how this impacts fish populations, but uncertainty is high as is interannual variation.

Bottom-up. Primary productivity is low and has experienced a long term decline. Linked to grazing by invasive clams and to shifts in nutrient concentrations, especially ammonium. Decline in food availability. Also major changes in plankton community composition, with a decline in food quality. Smelt food has shifted from diatomes to microcystis and small copepods. Changes in quantity and quality of food a major influence. Not the sole cause: declines preceded the POD; current clam pops not unprecedented.

Conclude that the POD is caused by multiple and often interacting drivers.

Linking to management in four ways: 1) focus on how the life history stages are affected by various drivers, then, using existing conceptual models, target those drivers.

2) assuming that an ecological regime shift has affected the entire estuarine ecosystem. Drivers are distinguished based on their approximate rate of changeand their importance to ecological resilience. Slow drivers contributed to the slow erosion of resilience. This made the system more susceptible to effects that happened rapidly around the time of the POD and/or had more species specificity. Slow drivers in order of importance: outflow, salinity, landscape, temp., turbidity, nutrients, contaminants, harvest.

Notes: they recognizize exogenous drivers, such as climate and geology that affect large regions and take long periods of time to develop. At the other ned or small – scale rapid events, such as fires, floods, droughts, disease etc. The operational scale is similar to biological response times. For this reason, the fast variables are the ones that get the most attention. Yet it is the slow variables that define and drive ecosystem change and character.

They note regime change and the problem of hysteresis associated with non-linear responses. AS part of this, they define a series of changes beginning with the gold rush (sediment and reclamation), then the post-reservoir period (changes in outflow, invasions), the the POD period (changes in food quality, quantity (although this is not tied to the POD collapse), massive expansion of invasives.

They argue that the abruptness of the POD is an expression of a regime shift. Define it as the new conceptual model for the POD. Explains the fact that many of the changes that are assumed to be part of the POD began much earllieruy

They list in order of importance, 8 "slow" drivers that have led to a regime shift in the Delta. And their order of importance: outflow, salinity, landscape, temperature, turbidity, nutrients, contaminants and harvest.

Outflow involves volume and timing

Salinity: tied to long term trends in environment. Starting in 1968, was decoupled. Ideal for invaders.

Landscape: loss of heterogeneity due to reclamation. Not the landscape that native evolved in. Habitat loss, coupled with predation and competition from non-natives probably the greatest transformation. This fixed landscape makes the present POD resilient and contributed to the loss of resiliency. Cannot adjust.

Temperature: once highly variable in space and time, particularly in tidal habitats. Today, warmer and more uniform temp stabilizes the current POD regime.

Turbidity: reduced sediment and organic matter, loss of seasonal variability. Decline both benefits and disturbs native species (not a stressor).

Nutrients: originally quite high, but low N:P ratios. Total N has increased, while total P decreased, reflecting Sac treatment plant. Which also increased nitrogen, especially ammonium. Changed ratios. This helped drive and stabilize the current POD regime, by changing food webs and promoting SAV.

Contaminants: overall increase, despite CWA restrictions. Not good data, but sublethal effets appear to be important.

Harvest: losses. Top-down portion of the box. Includes physical entrainment as well as fishing. This applies well to salmonids. Predation an important issue. Important to note that it is fundamental to the structure and function of ecosystems. Necessary tomaintain resilience. Changes favor invasive predators which are changing the ecology.

The new pelagic regime: lower outflows, shifted/constricted salanity gradient, simplified and rigid landscape, warmer temps, lower turbidity, higher ammonium/lower P, higher continant loads and higher losses due to entrainment and predation. The new benthid regime dominated by invasive species that exert a major bottom-up effect. There is a ndew littoral regime with the loss of tule marshes. SAV dominated.